Industrial Eye, LLC

Error-proofing and cost reduction

Answers about MACHINE VISION and LEAN MANUFACTURING

Categorized by industry and application.

Note: No proprietary images of products or other confidential customer information is disclosed in this document.

Approved images start on page 28…

THE BOTTOM LINE
(what you'll gain)

INDUSTRIAL EYE

- In this presentation you will learn how to use **MACHINE VISION TECHNOLOGY** to:
  - Find opportunities for process improvement
  - Improve quality with lower cost
  - Find issues before they unfold
  - Assess the new system performance
- Moreover, you'll have examples of how it's done with a *process roadmap for success*

THE BOTTOM LINE
(what you'll gain)

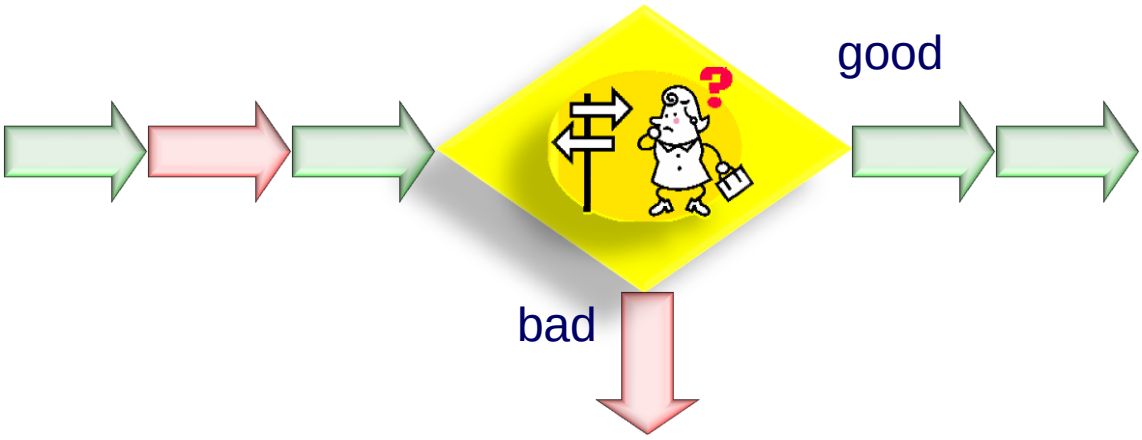
INDUSTRIAL EYE

- PART 1.1:
  - Find opportunities for process improvement
  - *The following section provides examples of how vision may be applied in existing operations.*

1.1: Find opportunities for improvement
(Do you have a Vision opportunity?)

INDUSTRIAL EYE

- ***Manual inspection and gauging?***
  - **Most inspection is 80 to 90% effective**
  - **Labor is costly**
  - **Subjective / inconsistent results**
    - **A "*false negative*" means a good product was rejected.**
    - **A "*false positive*" means a bad product was accepted!**
    - ***BOTH* defect types are avoidable!**

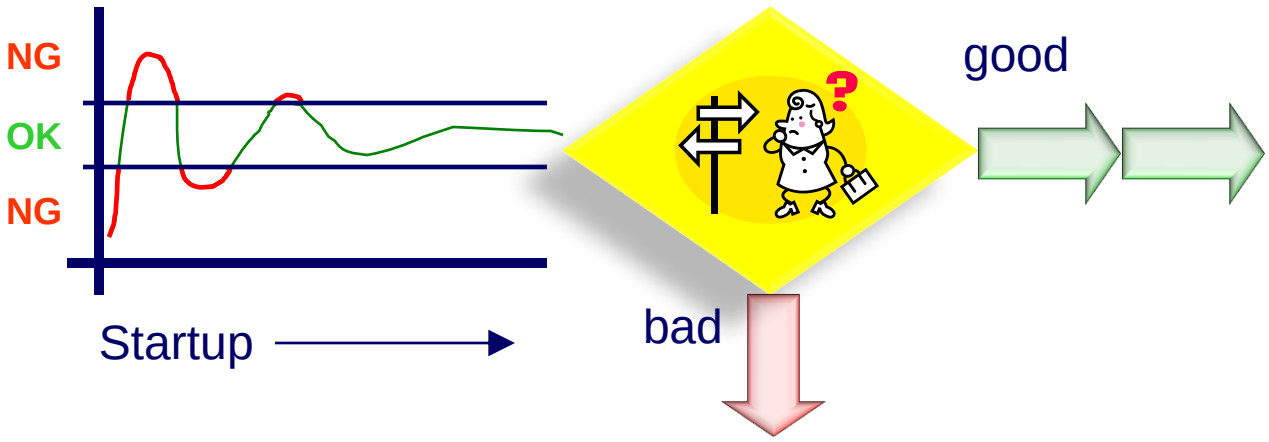


1.1: Find opportunities for improvement (Do you have a Vision opportunity?)

INDUSTRIAL EYE

- ***Eratic startup -- scrap issues?***
  - **Startups are busy for operators**
  - **Many defects are missed at this time**
  - **Most inspection is 80 to 90% effective**
  - **A "*false negative*" means a good product was rejected. COSTLY**
  - **A "*false positive*" means a bad product was accepted! TRAGIC**

✓ ***BOTH ARE AVOIDABLE WITH VISION.***

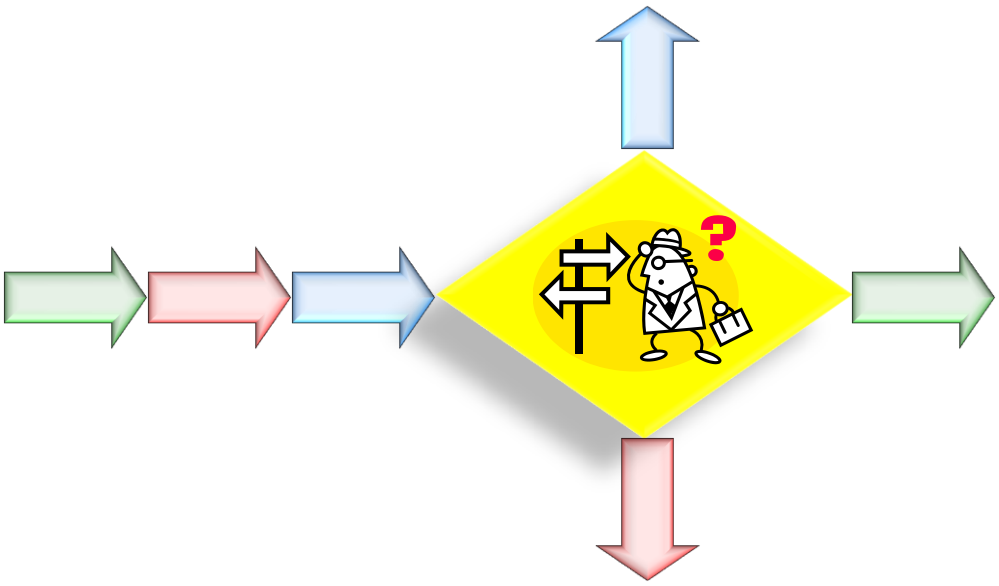


1.1: Find opportunities for improvement (Do you have a Vision opportunity?)

INDUSTRIAL EYE

- ***Manual routing and tracability?***
  - **Training intensive**
  - **High labor cost**
  - **Inconsistent / subjective**
  - **Can be inflexible**

✓ ***VISION REMOVES VARIABILITY AND LABOR.***

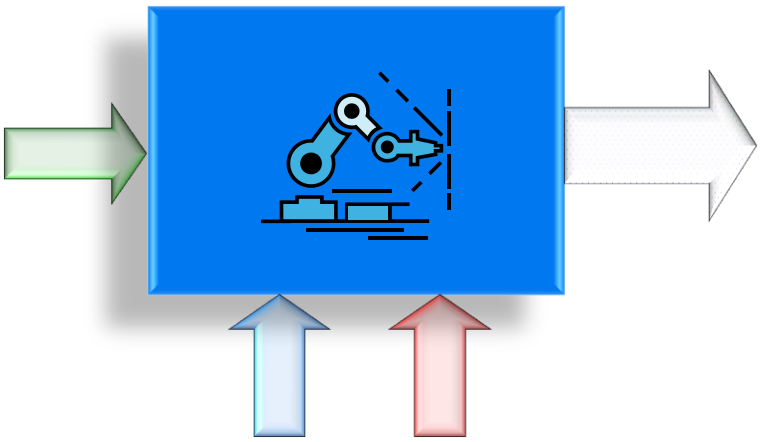


1.1: Find opportunities for improvement (Do you have a Vision opportunity?)

INDUSTRIAL EYE

- ***Semi-auto / Automated assembly?***
  - **Poka yoke (error proofing)**
    - **Checks component quality**
    - **Simplifies fixturing**
    - **Can do followup inspections**
  - **Provides process control data**
  - **Consistent performance validation**

✓ ***VISION GUIDED ASSEMBLY SAVES TOOLING AND MATERIAL.***

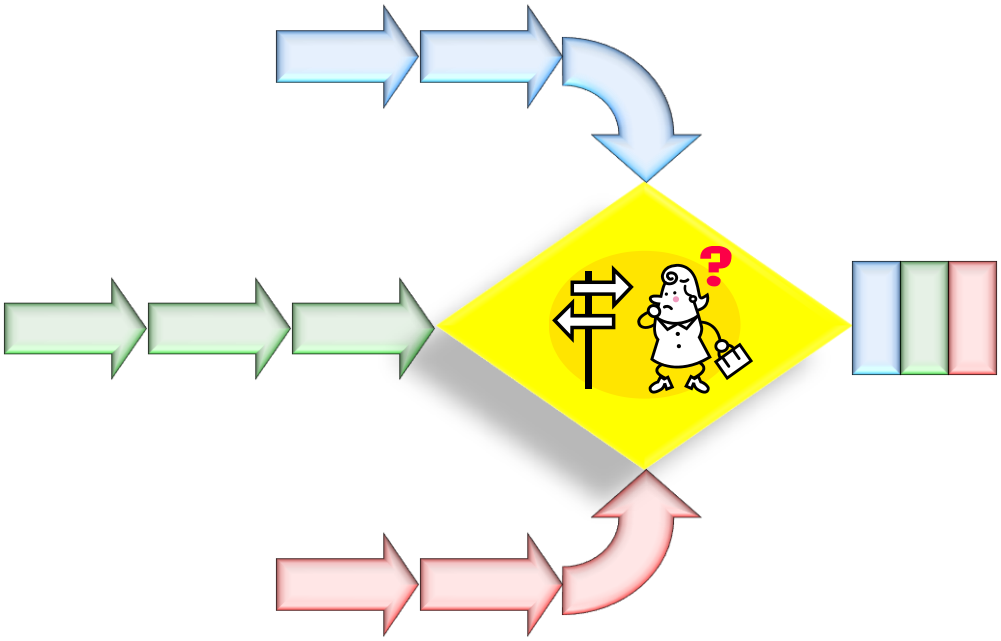


1.1: Find opportunities for improvement (Do you have a Vision opportunity?)

INDUSTRIAL EYE

- ***Manual packing?***
  - **Repetitious movement**
  - **Labor and space intensive**
  - **Difficult to validate**

✓ ***VERIFY THE COMPONENTS AND THE PACKAGING WITH VISION.***



1.1: Find opportunities for improvement (Do you have a Vision opportunity?)

INDUSTRIAL EYE

1.1: Find opportunities for improvement (Do you have a Vision opportunity?)

INDUSTRIAL EYE

- **Countless other opportunities exist in industries including…**
  - Aerospace
  - Automotive
  - Consumer products
  - Electronics
  - Medical/pharmaceuticals
  - Ordnance
  - Confectionary
  - Food and beverage
  - Packaging
  - Printing
  - Robotics
  - Tracability
  - Logistics

THE BOTTOM LINE
(what you'll gain)

INDUSTRIAL EYE

- PART 1.2:
  - Find opportunities for process improvement
  - Improve quality with lower cost
  - *The following section overviews the important concepts of error proofing as they relate to machine vision.*

1.2: Improve quality with lower cost.
The factors that comprise Return on Investment (ROI) for vision system

- Factors that influence the ROI calculation include:
  - Costs of…
    - product recall
    - quarantine and manual sorting
    - normal manual inspection
    - scrap
      - reduced setup scrap
      - reduced production scrap
        - catch a problem early
        - prevent successive defects
    - rework
    - down time reduction
    - change over time reduction
- Calculate the annualized sum of these factors and DIVIDE IT INTO the system cost – **i.e., ROI = Cost/Savings.**

ROI <1 means payback is less than one year.

1.2: Improve quality with lower cost.

Poka Yoke Summary

- **This section tells how Machine Vision – properly applied as a "*poka yoke*" – can reduce costs and errors in material handling and manufacturing.**

- ***Poka Yoke*** is a Toyota term for "*error proofing*"
- It typically has a very ***favorable payback***.
- Poka Yokes can benefit virtually ***any*** mfg. process.
- A poka yoke ***prevents errors*** in both **manual** operator tasks and **machine operations**.
- Machine vision systems (computers that can see) are ***simple to change-over*** to new parts -- simpler than mechanical poka yokes with change parts.
- Poka yoke candidates include parts that require ***verification, measurement, robot vision, orientation, matching, sequencing, material handling, sorting, etc.***
- Return on investment (ROI) is ***easy to calculate*** based on accepted guidelines.

1.2: Improve quality with lower cost.
What is a Poka Yoke and why do we need one?

INDUSTRIAL EYE

- "Poka Yoke" is loosely defined as a means of error-proofing a process by *limiting opportunities for operators to make mistakes*.
- This *applies to machine malfunctions too*.
- **Machine vision** provides a simple and highly reliable means for **non-contact** poka yokes that prevent errors from proceeding past the inspection point.
- This makes them highly adaptable and robust
- Mechanical Poka Yokes have practical limits for machine and operator.

Shigeo Shingo pioneered the concept and then coined the term as part of the Toyota Manufacturing System

1.2: Improve quality with lower cost.

Typical uses for a Vision-enabled Poka Yoke system

INDUSTRIAL EYE

- **Typical non-contact Poka Yokes:**
  - Confirming part orientation or identity by optically detecting features, marks or codes
  - Inspecting parts to *prevent rejects* from proceeding into the process
  - Detecting mis-feeds or jams at part in-feeds or conveyors
  - Confirming correct processing with post-process inspection
- ☑ **Seen to be significantly more flexible than hard tooling or proximity sensors**

THE BOTTOM LINE
(what you'll gain)

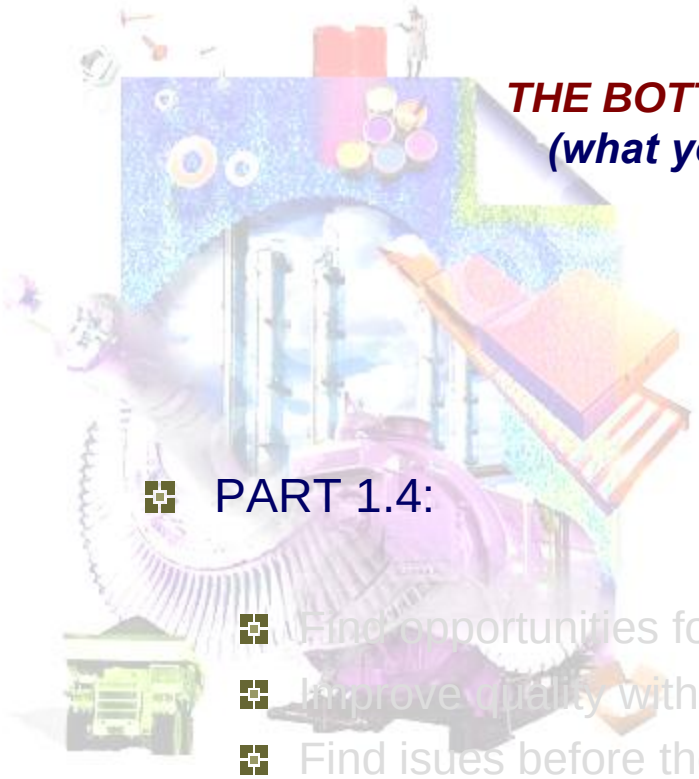
INDUSTRIAL EYE

- PART 1.3:
  - Find opportunities for process improvement
  - Improve quality with lower cost
  - Recognize issues before they unfold

  - *The following section describes predictive qualities of vision systems that make them useful in preventing problems.*

1.3: recognize issues before they unfold.
Data-driven decision making

- **Unlike manual inspection which typically requires inspection logging and process documentation, machine vision systems routinely integrate with plant information systems and statistical reporting packages to provide PREEMPTIVE information on the health of the a monitored process.**
- ☑ **Seen to be significantly more effective in controlling variability and risk than SPC or manual supervisory methods.**
- ☑ **Process capability is routinely calculated as a 'self-check' function**



THE BOTTOM LINE
(what you'll gain)

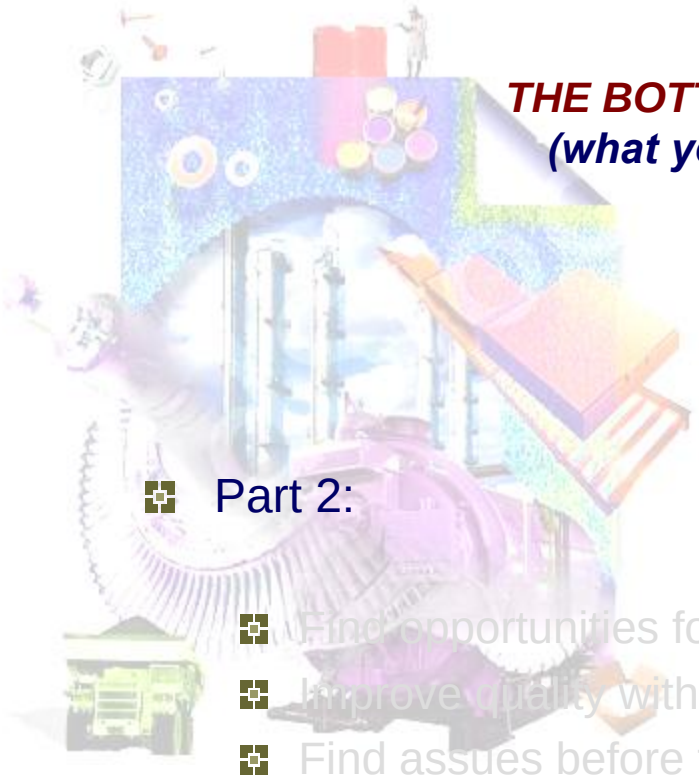
INDUSTRIAL EYE

- PART 1.4:
  - Find opportunities for process improvement
  - Improve quality with lower cost
  - Find isues before they unfold
  - Assess the new system performance

  - *The following section describes the runoff and ongoing testing of vision systems that is required to succeed in the long run.*

1.4: recognize issues before they unfold.
Data-driven decision making

- **Scheduled systematic testing of all functions and activities of the vision system provides an effective and documented means for checking performance.**
- **Challenge parts representing each failure mode may be periodically re-tested to give a quantitative measure of system stability.**



THE BOTTOM LINE
(what you'll gain)

INDUSTRIAL EYE

- Part 2:
  - Find opportunities for process improvement
  - Improve quality with lower cost
  - Find issues before they unfold
  - Assess the new system performance
- Moreover, you have examples of how it's done and the process roadmap to success
- *The following section discusses various families of applications and examples of each and that's followed by brief descriptions of specific installations in the field.*

How is this done?

One must have knowledge of machine vision components and accessories. This is critical.

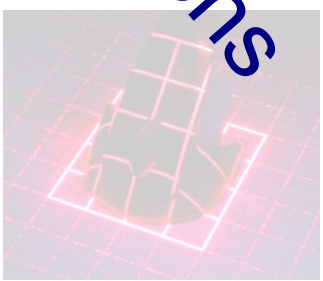
INDUSTRIAL EYE

various lenses

wide range of cameras

exhaustive lighting options

special optics designs



How is this done?

Each categories has its Own unique process for Problem definition, specification and design

INDUSTRIAL EYE

- **LEAN MANUFACTURING applications in the Machine Vision industry are thus categorized**

- **Gauging:**
  - *Dimensional Checks,*
    - *Area, Angle, Distance*
    - *Shape, Profile, etc.*

- **Guidance:**
  - *Rough- & Fine-Locating Parts for Robotic Pick-and-Place*
  - *Orienting Parts for Final Assembly*

How is this done?

Each categories has its Own unique process for Problem definition, specification and design

- **LEAN MANUFACTURING applications in the Machine Vision industry are thus categorized**

- **Identification:**
  - *Sorting Parts for Appearance,*
  - *Routing Batches of Parts Based on ID*
  - *Reading Human Readable Characters or Barcodes*
  - *Verifying a Decoded String Against a Database*
  - *Verifying Print Quality*

- **Inspection:**
  - *Verifying Attributes,*
    - *Shape*
    - *Composition*
    - *Relative Placement*
    - *Color, Gloss, Finish, etc.*
  - *Finding Missing & Extra Details*
  - *Kit Assembly Verification*

How is this done?

What to expect from a Poka Yoke system provider

INDUSTRIAL EYE

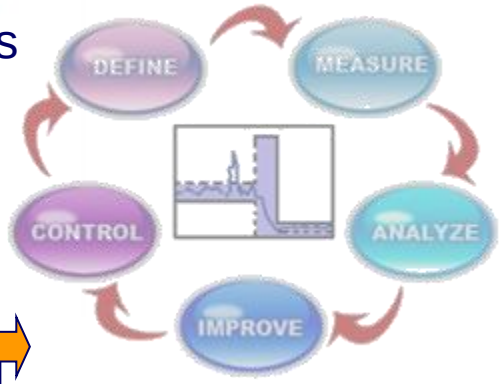
- ☑ Vendor commitment and partnership
  - ☑ To deploy Poka Yoke systems using the best available development processes and technologies.
  - ☑ To cooperatively devise the optimal solution for delivering the automated, validatable systems.
  - ☑ To Develop, Implement, Validate, Train, Maintain and Monitor the systems to the highest quality levels.

How is this done?

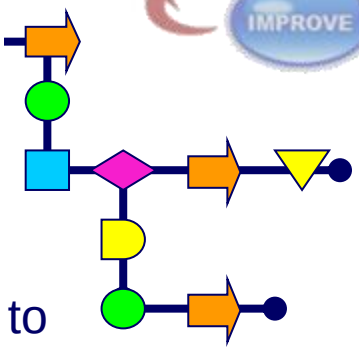
The Lean Tool Set that We use to define the Problem and the solution

INDUSTRIAL EYE

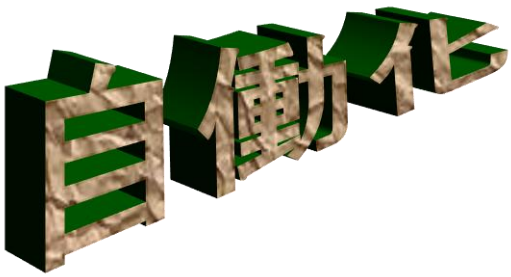
- **DMAIC** process guides discovery and implementation



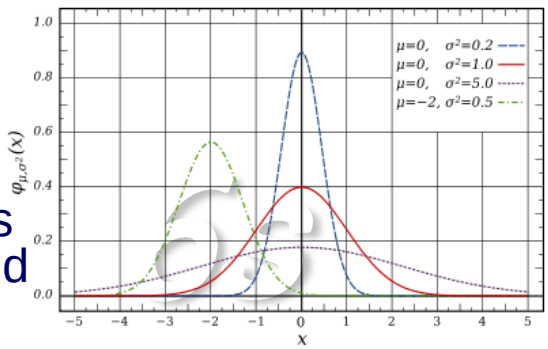
- We use *your* **value stream mapping** to discover the best candidates



- **Jidoka** (appropriate automation) is used to automate and address root causes



- **Six sigma** focuses on participation and collaboration



How is this done?
Stages of the Integration Approach and followthrough

INDUSTRIAL EYE

☑ **D.I.E.T.**

discovery
- process
- reasoning
- scope
- corp culture

invention
- off the shelf
- custom
- partners
- proposal
- negotiation

execution
- planning
- build out
- testing
- FAT
- installation

technology transfer
- user training
- admin training
- maintenance
- upgrade path

How is this done?
Ten hard truths Of Machine Vision Development

INDUSTRIAL EYE

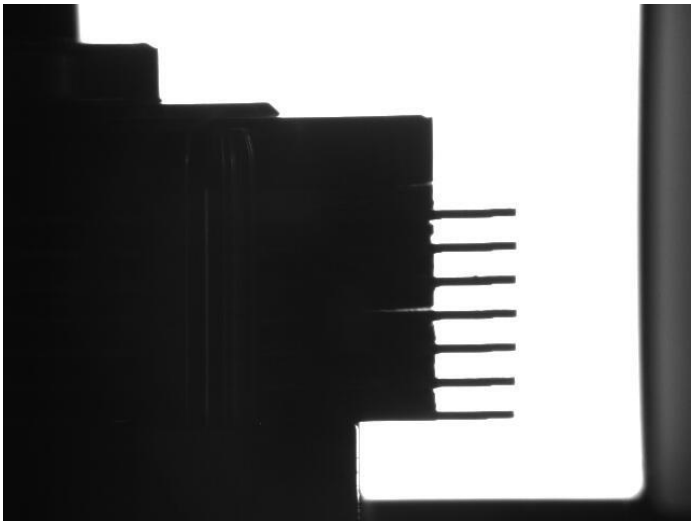
1. **Location is everything** – that is, the location of lighting, location of the cameras, location of the fixturing, location of the debris/oil on parts, etc. **The system's architecture (physical, optical, environmental) largely sets the stage for success in the later phase of software development.**
2. **The 80/20 rule** – 80% of your project labor will be spent on the last 20% of the job. **Early design mistakes will be costly to correct if they're not caught until the late stage of optimization.**
3. **There's probably an easier way** – in many cases, machine vision can be replaced or augmented with other sensing technologies that may work *differently*, but equally well. **A thorough engineer uses vision as a technology of last resort, favoring less elaborate approaches and technologies.**
4. **Vision bites back** – vision projects can have more natural variability than other controls projects and often surprise newcomers with the extent of the discovery period and testing required to develop a project specification. **Some processes have varieties of variability that are revealed for the first time by the camera and thus consideration must be given to fact-finding well into the vision system design process.**
5. **Murphy is watching so work with Pro's** – assemble a team that contains specialists in I/O, optics & lighting, control, vision programming, mechanical design, networking, etc., to support the deployment. **Because a simpler approach may be 'waiting around the corner' it is beneficial to seek experienced professionals in mechanical engineering as well as controls when concepting the dynamic parts of the system.**
6. **Orders of 10** – a new phenomenon, thought to be unlikely or impossible, will emerge at roughly 1,000 parts, 10,000 parts, 100,000 parts, etc. **It's very important for the system to be fail-safe – that is, to fail images that exhibit gross deficiencies or excesses from the expected image.**
7. **If the plant doesn't want it, it won't work** – day to day buy-in from process and maintenance staffs is critical to the successful deployment of any project, but especially so for vision systems that typically require PM. **The importance of operator training and clear guidance to the operator through the GUI will make plant acceptance and trust much easier to attain.**
8. **ShiFt Happens!** – a client who believes that the properties of parts will not shift or that process variability is completely understood (prior to a study with real optical gear) is quite possibly being naïve. **Incoming material flows will always vary and the limits of that variance must be thoroughly characterized – even if it can't be controlled – within the vision system.**
9. **Cheap gear costs double** – components chosen on price typically disappoint the whole team. **Understand the budget and the ROI. Making compromises in hardware or software for the sake of cost will most likely hurt the project.**
10. **Miracles out of nowhere** – in many cases, a technology applied in a different industry can hold the key to a novel or breakaway approach to your application. **A broad knowledge of vision and a base of experience can infuse the design and development with fresh and helpful perspectives from diverse industries.**

Example images showing the results of some of these methods

INDUSTRIAL EYE

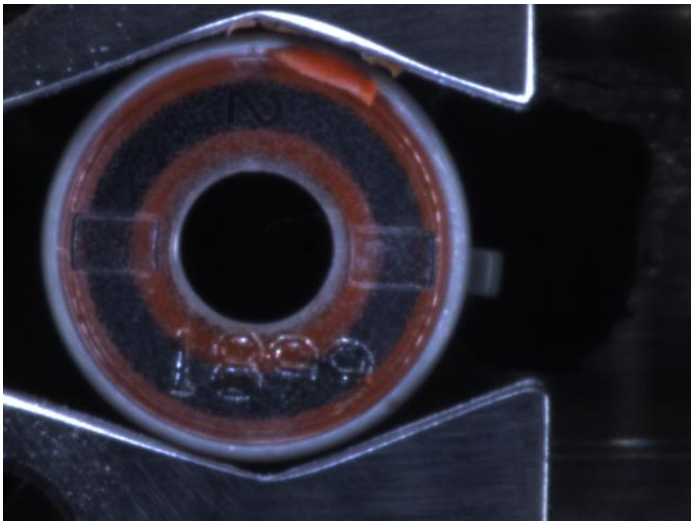
- 24 actual part images with brief descriptions

Stack height measurement



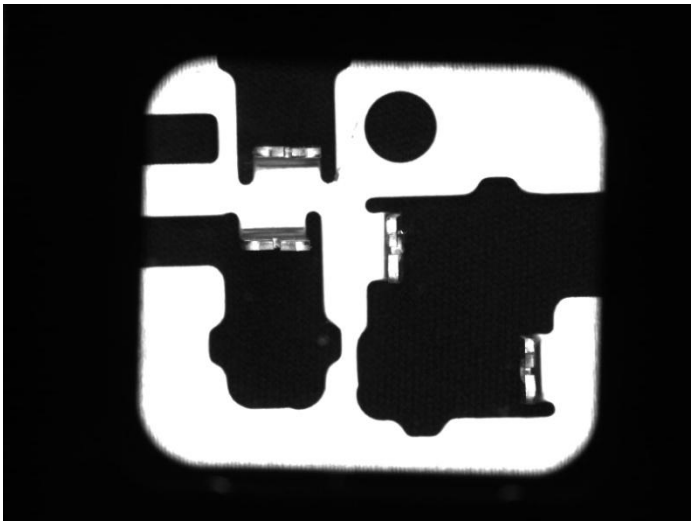
- Counting widths of black tabs and the widths of the intervening white gaps
- Tab and gap arrangement configurable through I/O.
- Backlight and telecentric lens required.

Red o-ring inspection



- Checking for correct placement of inner and outer O-ring.
- Color of O-ring often changes with the batch.
- Low angle lighting and color tools are required for flexibility in color

Stamped tab measurement

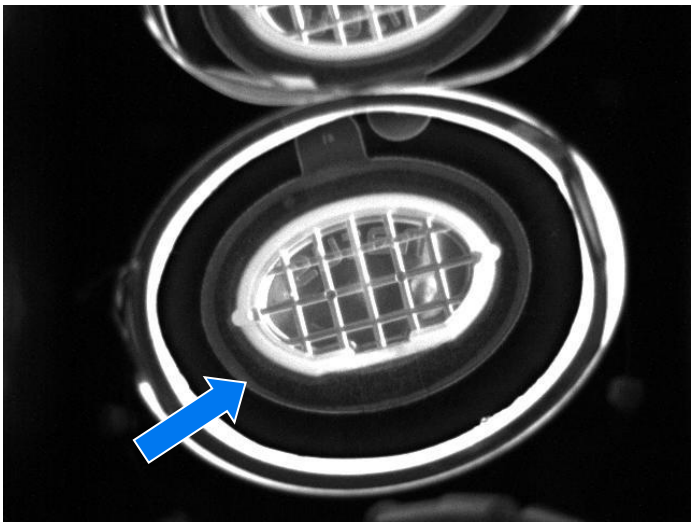


- High precision gauging of the location of the formed tabs to the opposite face.
- End grain of the tab clouds the result and is overcome in software
- On-axis strobe lighting and telecentric lens required.

Weld wear inspection using dye penetrant

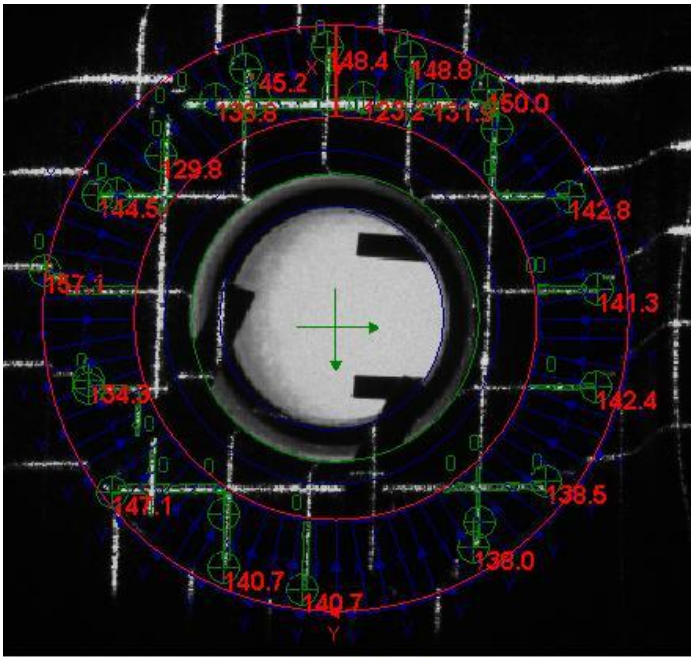
- Camera inside a sealed box with controlled height, pitch and yaw inspects welds for cracks
- High-output UV light and two cameras with a shared lens required to meet the measurement spec.

Adhesive inspection



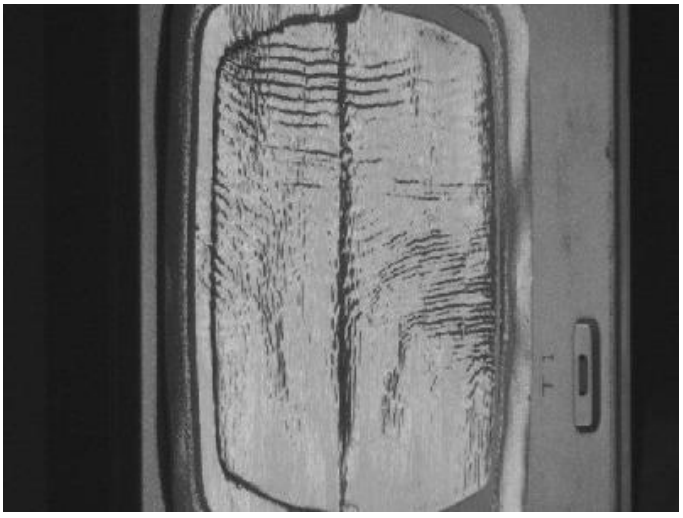
- This haze of the meniscus of the glue is visible where the arrow shows. This must be visible around the entire eliptical perimeter of the part.
- The adhesive is transparent. Also bubbles and debris must be detected.
- Custom electro luminescent light fixtures and custom software is required

Measurement of 3-D concentric features



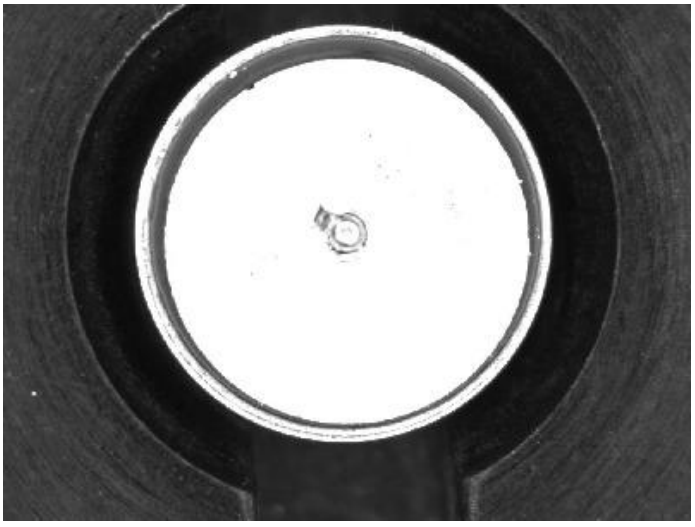
- Determining the stackup of concentric metal parts by projecting parallel light lines over the surface and measuring the contour.
- There is no visible color difference among the parts that make up the stack.

Low-angle roughness gauging on transparent medium



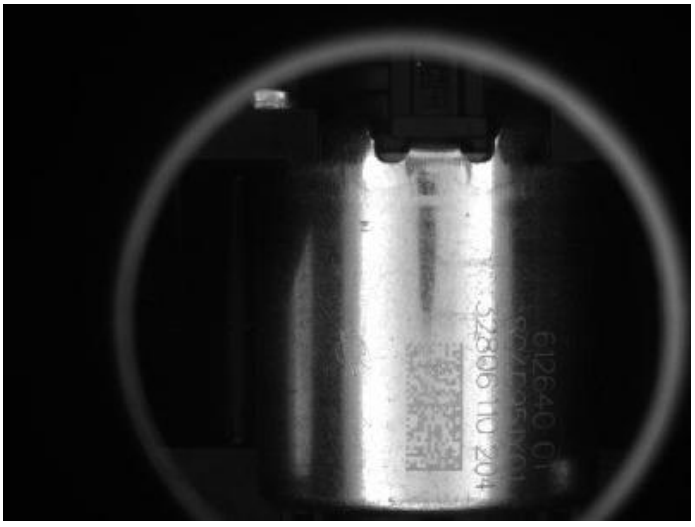
- Determining if stress lines are present in the surface of a transparent adhesive gel and if a stack of transparent components are in place using a custom low angle collimated light and a telecetric lens
- Parts had no visible contrast from a top-down view.

Concentricity measurement



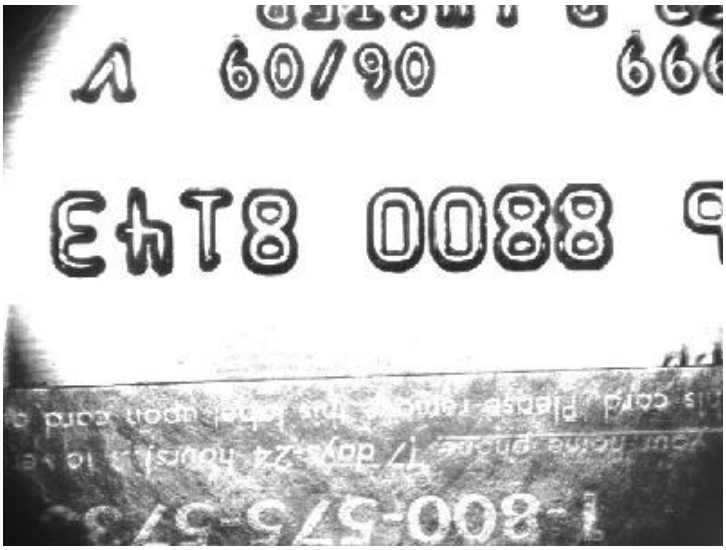
- Stack up of nickel, plastic insulator and lithium layers that make a battery
- Concentricity asssures the tooling is not fouled by the sticky lithium.
- On-axis light and high mag lens required.

Datamatrix reading on curved galvanized metal



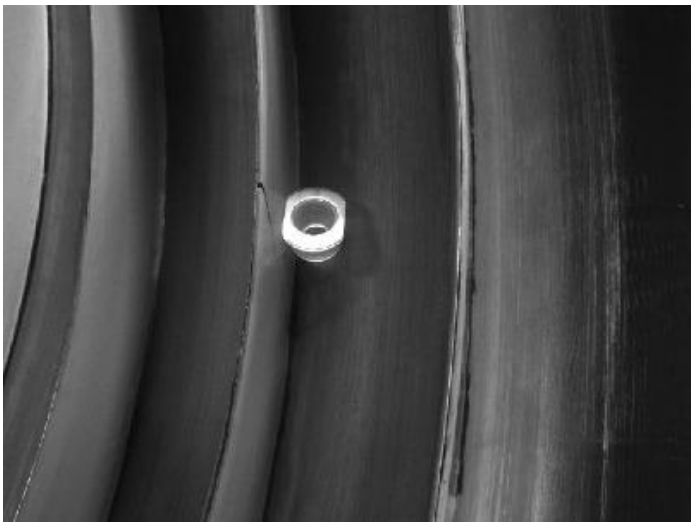
- Reading a rectangular 2D Datamatrix code on a mottled but highly reflective cylinder while in motion over the part
- Multiple strobe lighting sources from multiples angles were required to get adequate read rates.

OCR on optically noisy background



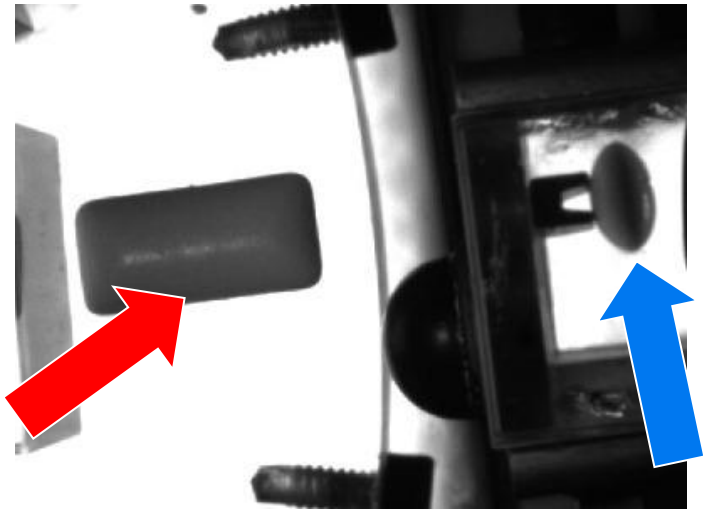
- Reading and matching credit card numbers on a very colorful and random-looking card background.
- The back-ground was washed out by the lighting angle and software used

Clean-out verification on a vibratory bowl feeder



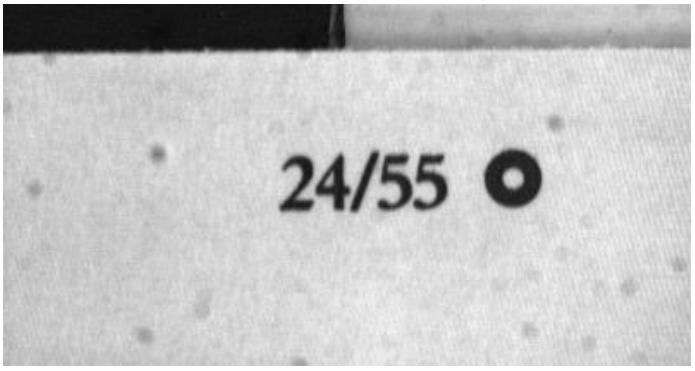
- Accounting for every small component from the line is required in many medical manufacturing applications.
- These parts easily get jammed in the bowl feeder and have to be detected by sweeping the bowl's inner surface with a camera.

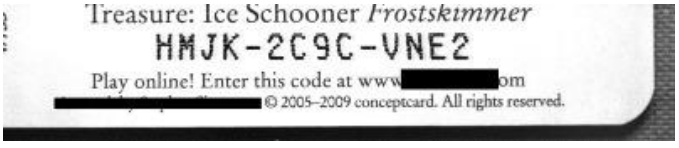
Dimensional gauging



- Checking the coating process on a sample of parts by performing an accurate measurement of the perimeter. Top view (red arrow), end view (blue arrow) required mirrors to combine the two perspectives into a single view.

Three part process: read, print, verify.



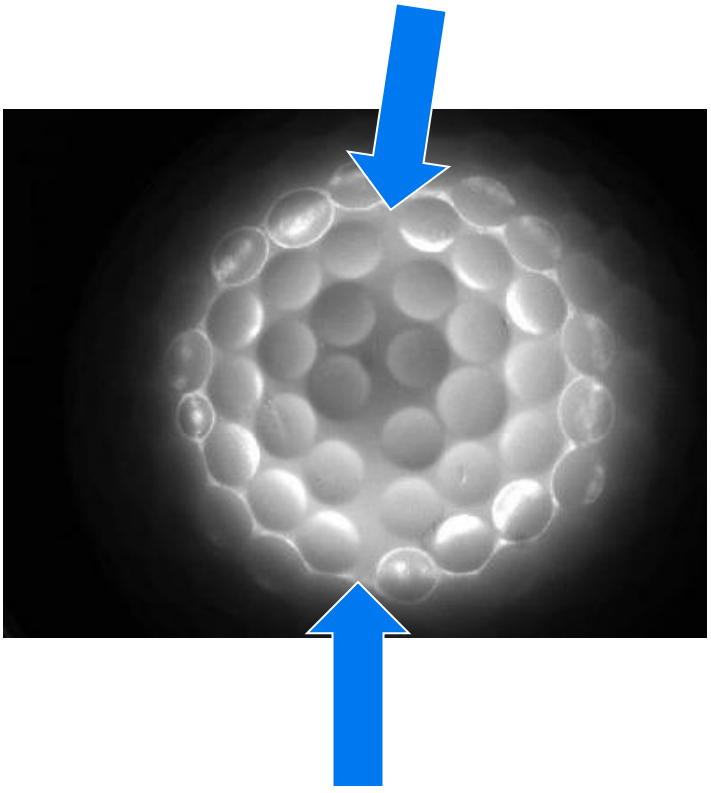


- A small stock ID number is read by the first camera and prompts the database to generate the 12 digit code below
- The code is sent to the printer and to the second camera.
- The code is verified in camera software

Print quality on pad-printed medical device

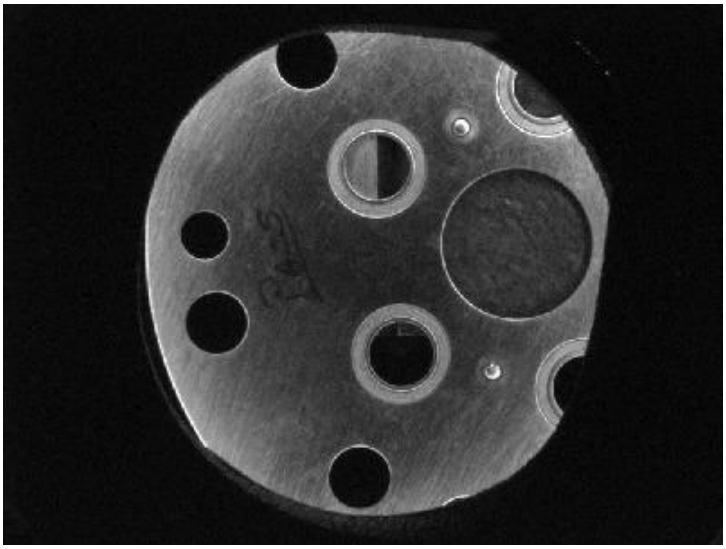
- Pad-printed text on this medical device is checked for missing or extra ink by the camera.
- The part is curved so special lighting is used to stop unwanted reflections from affecting the image.

Golf ball equator finder



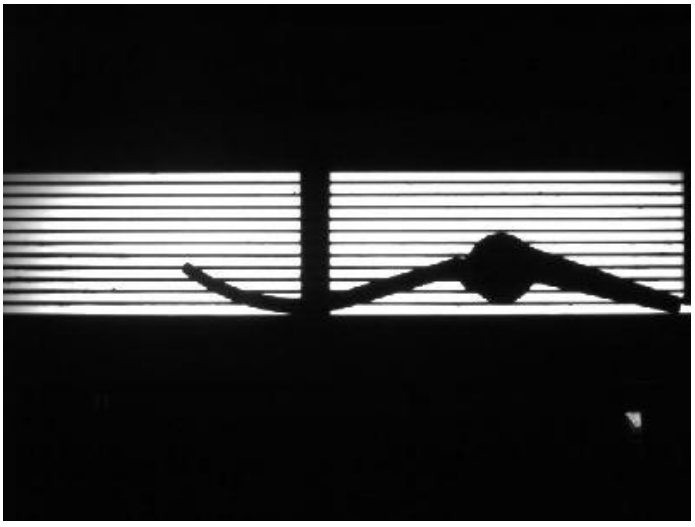
- The equator, (indicated by the arrows) is found and coordinates are sent to servo's to correct its orientation for printing.
- Special lighting and software are key to this.

Inspecting for machining marks



- The perimeter of this part is much lighter than the inner portion due to unpolished scratches that didn’t clean up well. Low angle lighting of long wavelength is used with a fast telecentric lens.

Robotic pick and place



- This pliers is located in X, Y and Rotation using the backlit plate seen here.
- The offset coordinates are sent to a robot for pick and place assembly.
- Backlighting, robot interface program and calibration software required

Housing orientation

- Identity and orientation of this rough housing is verified (other parts in the family are very similar) in its nest.
- Wrong or incorrectly rotated parts are addressed by an operator

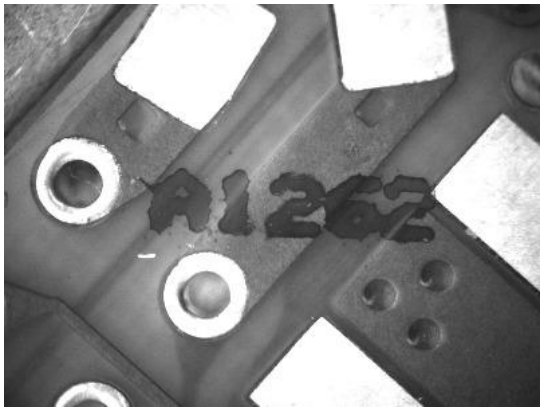
Black rubber seal inspection

- Checking for presence of horizontal black seal lips at bottom of seal
- High intensity off-axis light is used to light the black rubber. Stats are recorded for process control.

Clutch component inspection

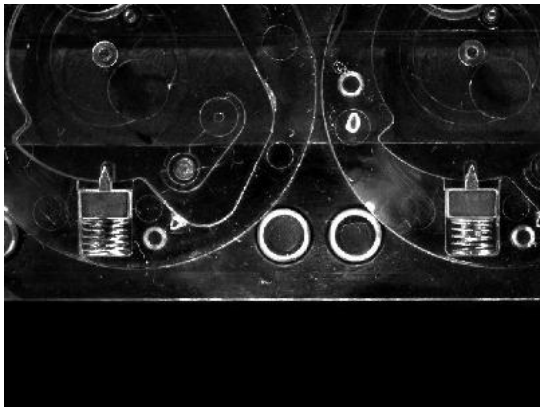
- Counts and orientation of various components are verified as this circular part is held in a rotating robot gripper.
- Telecentric lens and collimated backlight required.

Very small and degraded print verification



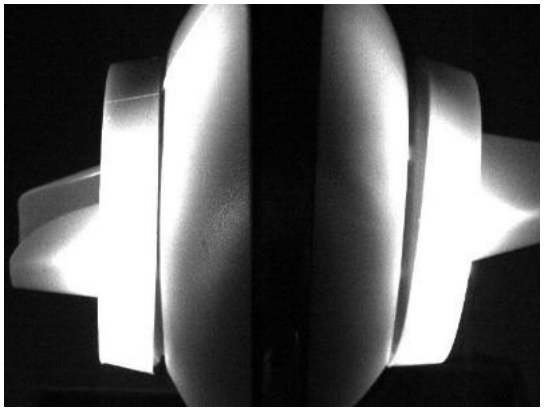
- Small inkjet text mark is verified by high-mag lens
- Special OCR routines are needed due to poor print quality at high magnification.

Component measurement



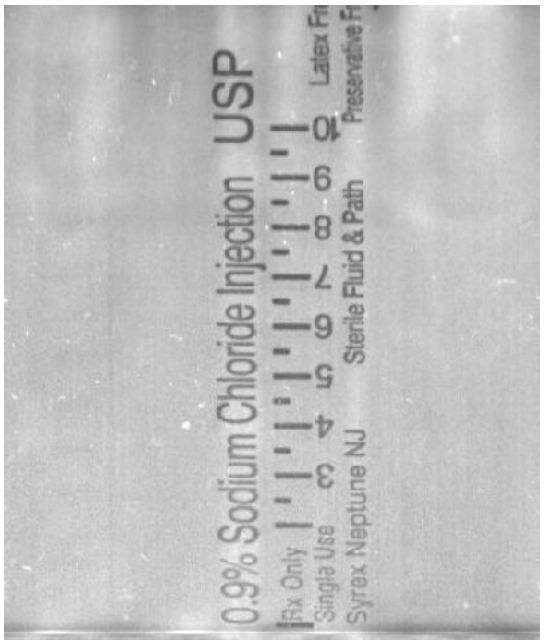
- Checking assembly verification and measuring the points on the sintered metal blocks at left and right.
- It used a synchronized strobe light to freeze motion.

Checking proper component insertion



- Cap at left is seated – cap at right is not seated.
- This is a single image of two views of the same part combined in the camera by an optical field splitter.
- It also required special lighting

Line scan image of label



- This is a line scan image of a defective syringe. Quality of the text is low.

Thank you!

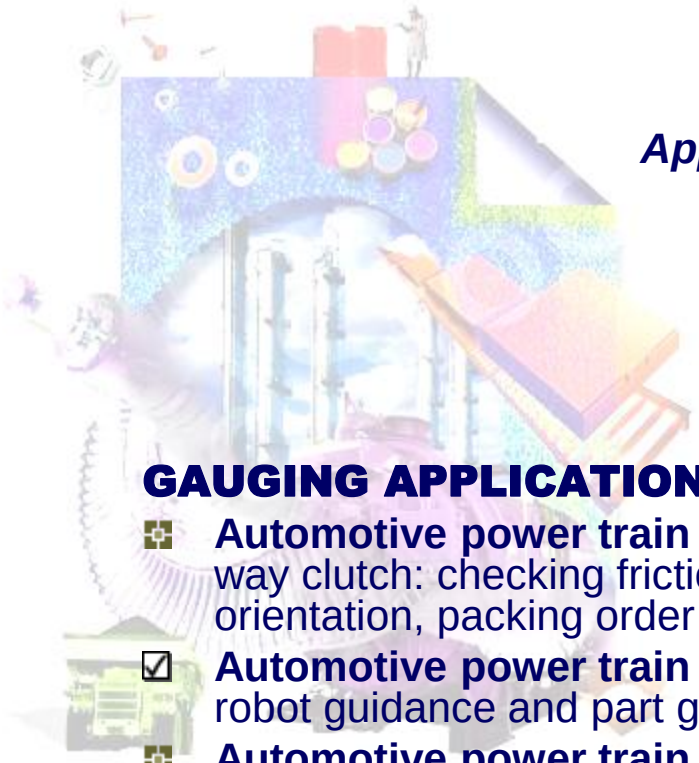
INDUSTRIAL EYE

"Industrial Eye has the expertise, creativity and experience to address many of today's LEAN MANUFACTURING challenges with Machine Vision technology"

☑ NEXT COMES A TEN PAGE APPENDICE OF APPLICATIONS FOR YOUR REVIEW. THESE CONSIST OF GUIDANCE, GAUGING, INSPECTION AND IDENTIFICATION APPLICATIONS SPANNING MANY INDUSTRIES.

Please contact us for more information
or to discuss your specific project.

Tel (847) 778 - 5245



INDUSTRIAL EYE

GAUGING APPLICATIONS:

- **Automotive power train maker**, friction and one-way clutch: checking friction plates for proper orientation, packing order and dimensional checks
- ☑ **Automotive power train maker**, one-way clutch: robot guidance and part gauging
- **Automotive power train maker**, 3-D gauging: measuring true position 3D of 10 punched holes on a rear axle assembly using moving cameras and laser displacement sensors
- **Automotive power train maker**, ring gauging: gauging piston rings for profile and tip to tip dimensions
- **Consumer products**, closure inspection: gauging plastic zipper prior to assembly onto a plastic zip-to-close bag
- **Consumer products maker**, label inspection: measured label position on molded plastic container
- **Consumer products maker**: finish inspection: checked dimensions of threads and seal surface on plastic containers

GAUGING APPLICATIONS - *continued*

- **Consumer products maker**, drip-cap inspection: gauging position of pour spout on liquid container
- **Contract inspection house**, fastener gauging: gauging screws and bolts for various attributes and dimensions
- **Contract plastic sheet former**, credit card gauging: checking placement of mag-stripe on credit card blanks
- ☑ **Electrical component maker** battery ass'y: Checking laser welded military lithium batteries for weld voids that would cause leaking and contamination
- **Electrical component maker,** battery stack verification: gauging the concentricity of a stack of military battery components prior to assembly
- **Electrical component maker**, pin gauging: checking pin-to-pin relative positions and offsets to the housing
- **Electrical component maker**, pin ass'y gauging: very high resolution gauging of hundreds of connector pins a housing

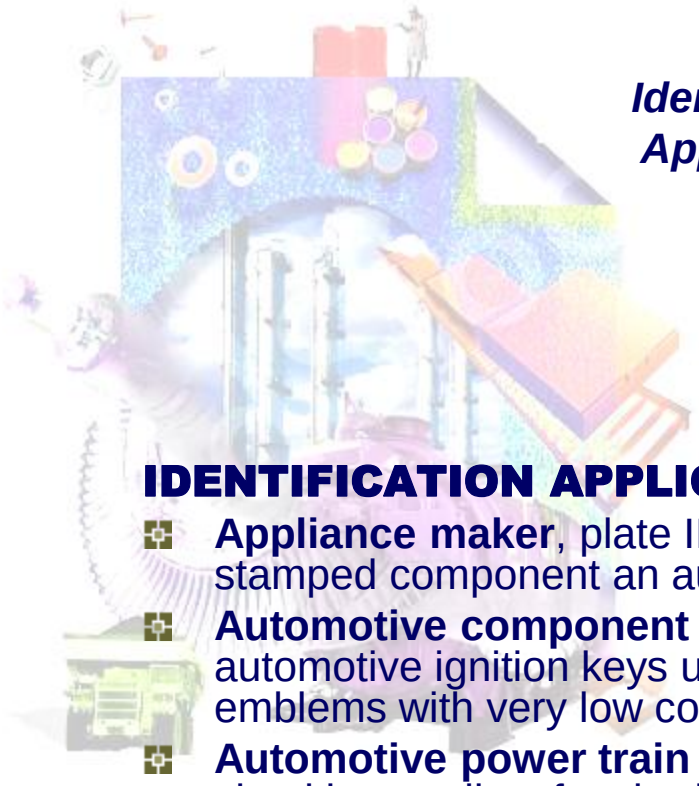
GAUGING APPLICATIONS - *continued*

- **Food maker**, thickness gauging: checking thickness of a rolled food product for lab QA
- **Hand-tool maker**, wire stripper gauging: checking various hole sizes on a wire stripping pliers
- **Medical device maker**, cannula gauging: checking cannula for length and for a crimp needed for the safety sleeve
- **Medical device maker**, part orientation: verification of sleeve placement relative transparent septum and outer fitting
- ☑ **Metal stamping**, stamping gauging: checking 38 pins for perpendicularity on a 5”x 10” substrate to within 0.003” in less than 4 seconds by indexing the part under the camera
- **Medical device maker**, septum gauging: assembly check and dimensional checks on valve parts
- **Office products make**r, nib inspection: dimensional checks on fountain pen nibs
- **Steel slitter**, hi-speed strip gauging: measuring mile-long continuous metal strips for width (+/- 0.002”) at 700 – 900 ft/min

INDUSTRIAL EYE

GUIDANCE APPLICATIONS:

- **Laser OEM,** part guidance: guiding a laser etcher for marking parts random orientation
- **Laser welder**, electrode welding: precisely locating a stainless steel electrode on pacemaker prior to laser welding
- **Machine builder**, robot guidance: guiding a robot to pick piston heads on the fly on a conveyor
- ☑ **Machine builder**, robotic guidance: picking food from a conveyor using an ABB Flex-picker at 3 picks per second on a 24x24” moving work area
- **Machine builder**, robot guidance: guiding a robot to pick piston heads on the fly on a conveyor
- ☑ **Orthodontics maker**, robotic pick and place of randomly oriented moving parts on a vibratory plate
- **Plastic injection molder**, robot guidance: part orientation for robotic stacking
- **Soldering robot OEM**, robot guidance: guiding a soldering robot to locations on a PCB based on calculated position corrections

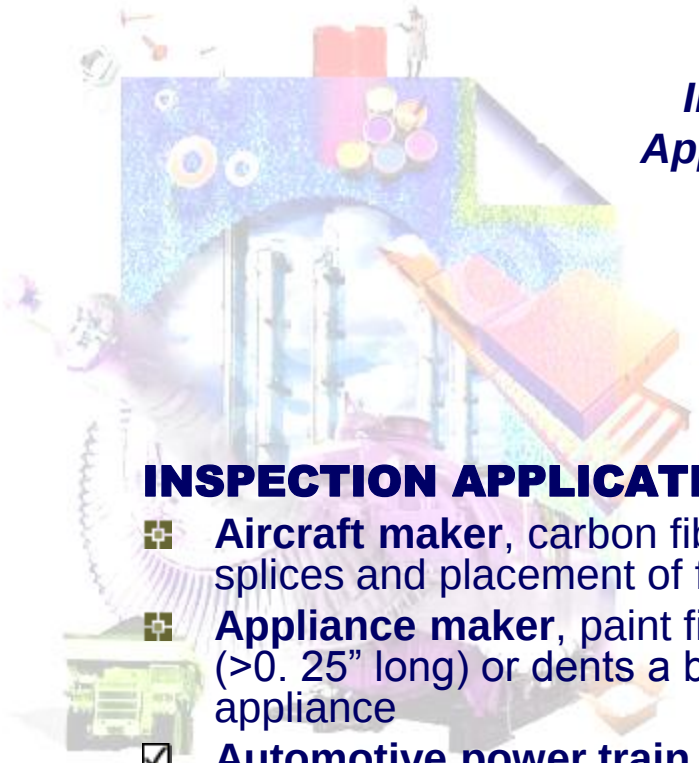


IDENTIFICATION APPLICATIONS:

- **Appliance maker**, plate ID: verifying correct stamped component an automated assembly robot
- **Automotive component maker**, key set ID: sorting automotive ignition keys using the embossed emblems with very low contrast
- **Automotive power train maker**, stamping ocr: checking quality of etched characters on discolored steel surface
- ☑ **Chip maker**, high speed 2-D barcode verification: checking laser etching placement and quality on plastic web at over 10 pieces/sec
- **Contact lens maker**, contact lens inspection, ocr: Optical character recognition of widely spaced small characters (0.050” tall) on small contact lens cartons for inventory control
- **Contract label printer**, print verification: checking food labels for print quality
- ☑ **Contract printer**, Verify brand app: reading unique printed codes on labels for entry into a tracking database for duplicate checking

IDENTIFICATION APPL'S - *continued*

- **Electrical component maker**, OCR: verifying character quality of part number (0.040" tall) on hearing aid PCB
- **Hand-tool maker**, pliers body ID: verifying the pliers component prior to robot pick for assembly
- **Machine builder**, catalytic converter ocv: checking for text on the flow-through end of a catalytic converter
- **Mailing services**, sorting and code reading: reading mailing label marks for internal sortation and routing characters
- **Mailing services**, code reading, cover verifier: reading label verifier string and matching to the corresponding book cover
- ☑ **Medical device maker**, vial inspection, ocv: checking clear plastic product for specs and cinders while verifying presence molded characters
- **Printer OEM**, print verification, code reading: reading printed characters
- **Radiological services**, radiation tag ID: identifying radiation tags returning from customers for database reconciliation



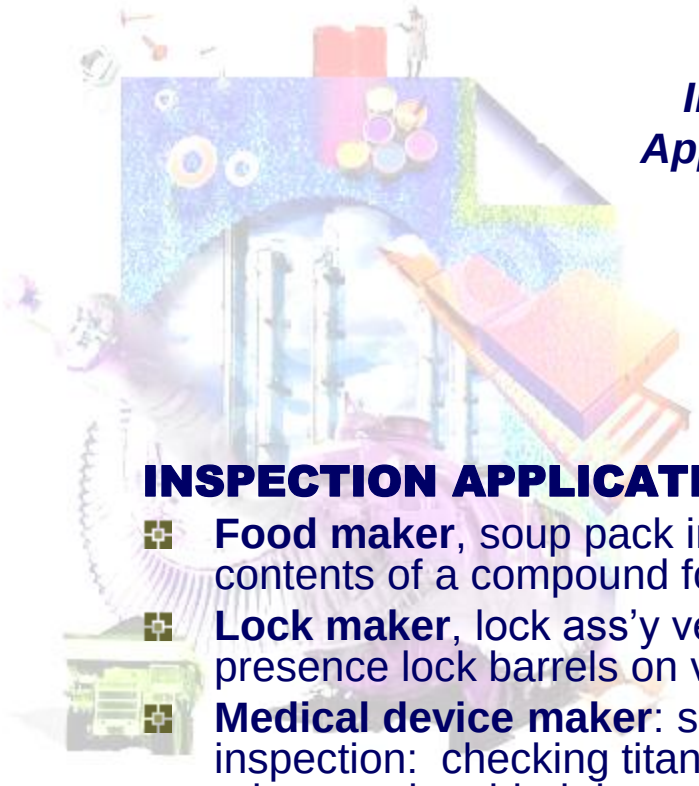
INDUSTRIAL EYE

INSPECTION APPLICATIONS:

- **Aircraft maker**, carbon fiber gauging: checking for splices and placement of fibers
- **Appliance maker**, paint finish: detecting scratches (>0. 25” long) or dents a body panel on a large appliance
- ☑ **Automotive power train maker**, sprag ass’y inspection: checking one-way clutch components for orientation and dimensions at 20 inspections/second
- **Beverage can handling**, crack inspection: checking large plastic separator sheets (for pallets) for cracks or breaks
- ☑ **Beverage distillery**, bottle finish inspection: checking bottle seal surface for chips or voids as small as 1-mm square at rates over 8 bottles/second
- **Candy maker**, mold inspection: checking for residual chocolate (>0.050”) multiple cavities simultaneously after mold rejection
- **Consumer products maker**, case pack verifier: verifying bottle pack-out packing cases

INSPECTION APPLICATIONS – *continued*

- **Consumer products**, can inspection: gauging can chime and cap on solvent cans for proper position and closure – an explosion-proof environment
- **Contract assembler**, assembly verification: checking wire color and insulator orientation on electrical plugs
- **Contract pad printer**, print verification: verifying quality of pad printing on medical parts
- ☑ **Contract PCB maker**, solder inspection: checking solder fusion and geometry
- **Engine seal maker,** fastener gauging, seal inspection: detecting black molding flash and short shots on black rubber parts and also detecting cracks white plastic inserts
- **Exhaust system maker**, catalytic converter. 3-D gauging: checking face of converter core for cracks or nicks
- **Food maker**, box count and config: checking box within a case for proper pack-out and box orientation
- **Consumer products maker**, spigot orientation and color: checking pour spot for placement and type



INSPECTION APPLICATIONS – *continued*

- **Food maker**, soup pack inspection: checking for contents of a compound food package
- **Lock maker**, lock ass'y verification: Verifying spring presence lock barrels on various lock bodies
- **Medical device maker**: surgical instrument inspection: checking titanium instrument for spray primer and molded rings
- **Medical device maker**, defib pad inspection: gauging relative placement of plastic substrate to tin conductor to the clear conductive hydro-gel layer
- ☑ **Metal container maker,** UV varnish inspection: checking can cover for a UV-visible rust inhibitor at 12 parts/second
- **Metal finisher**, metal surface finish: detecting metal gains (0.001" high) protruding above the surface of a polished metal laminate plate

INSPECTION APPLICATIONS – *continued*

- **Nuclear power services**, reactor head gauging: gauging weld voids and stress cracks nuclear reactor vessel
- **Office supply maker**, binder finish: checking binder ring closure and rivet formation on three-ring binders
- **Pad orientation**, pad print inspection: checking for non-conforming print (>0.008”) on oil filter end caps
- **Spring maker**, spring gauging, gauging springs for length and coil dimensions 3-D
- **X-Ray maker**, X-ray analysis: detecting metal tabs plastic molded part using X-ray